A Versatile User-Oriented Interface for Gesture Recognition Using Electromyographic and Inertial Measurement Unit Data

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BACKGROUND

Goal: Further develop an existing human-machine interface while keeping it low-cost, open source, and flexible

Motivation: Provide an "open to the public" human-machine interface that utilizes electromyography as its primary input

Advantages over other methods:

- Computer-vision: limited by the camera, its view range, and environment's lightning
- Motion-sensing gloves: bulky and inconvenient hardware to wear
- Low-cost: only $199 for the armband

OBJECTIVES

- Static and dynamic gesture recognition
- Develop a usability assessment test

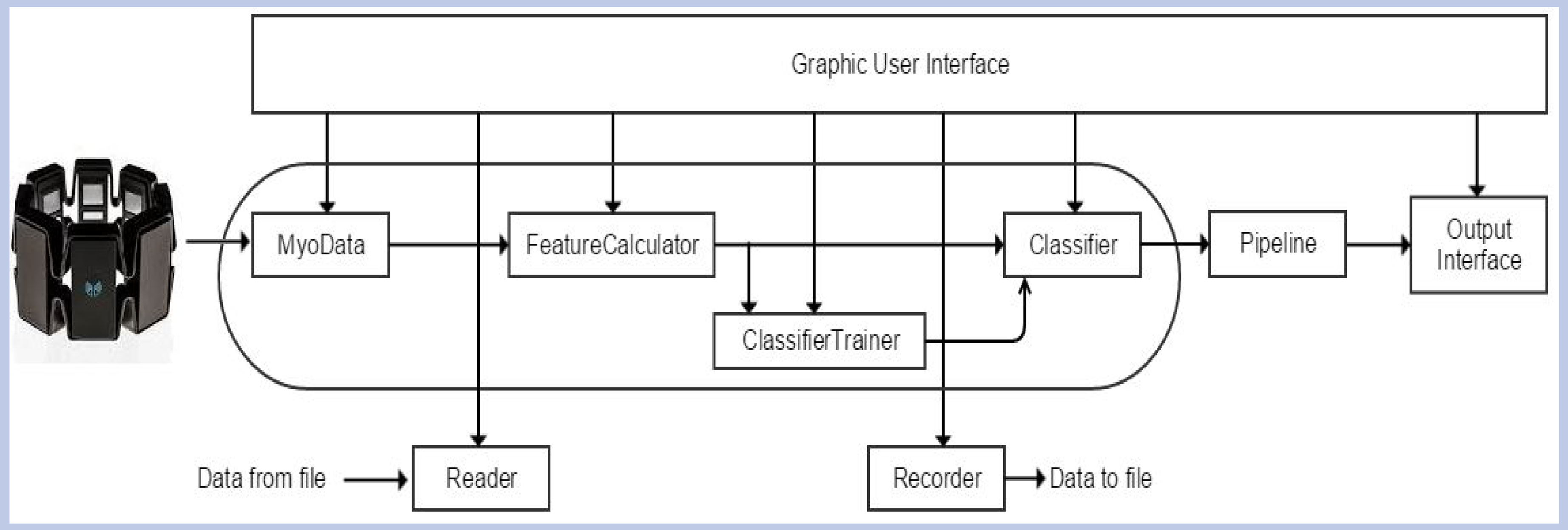
SIGNIFICANCE

Applications:

- Exoskeletons
- Prostheses
- Phobia therapy
- VR Gaming

MATERIALS & METHODS

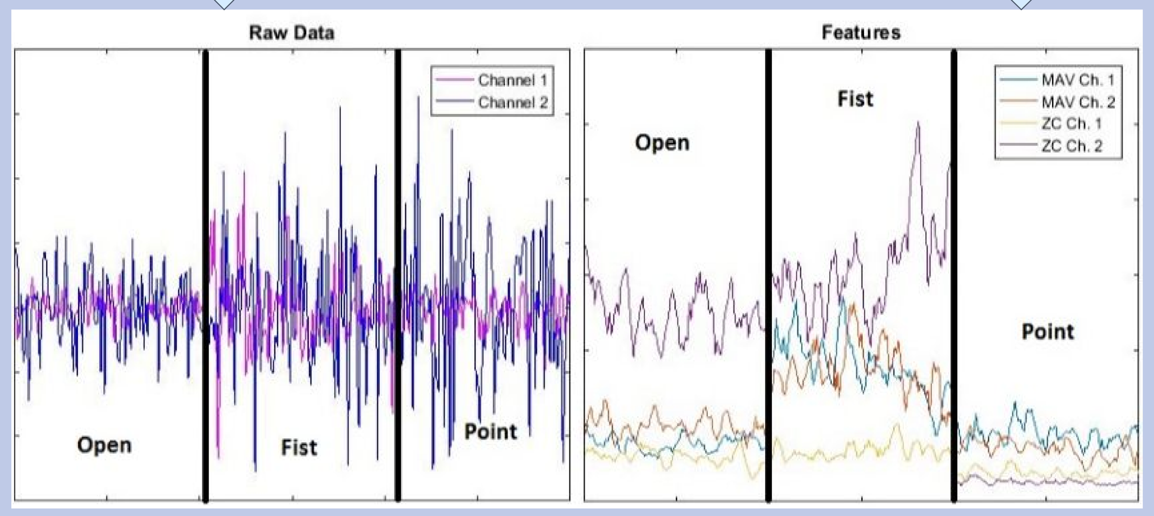
HMI Overview:



Myo Armband

- 8 EMG sensors, 200 Hz
- 9-Axis IMU sensors, 50 Hz
- Haptic Feedback
- Low Energy Bluetooth 4.0

Feature Extraction



Mean Absolute Value (MAV)

$$MAV_i = \frac{1}{N} s \sum_{k=1}^{N} |x_k| \ for\ i = 1, \ldots, I$$

Scale MAV (MAV/MMAV)

$$\frac{MAV}{MMAV} = \frac{MAV_i}{\frac{1}{I}\sum_{i-1}^{I} MAV_i}$$

Waveform Length (WAVE)

$$WAVE = \sum_{k-1}^{N} |x_k - x_{k-1}|$$

Slope Sign Change (TURN)

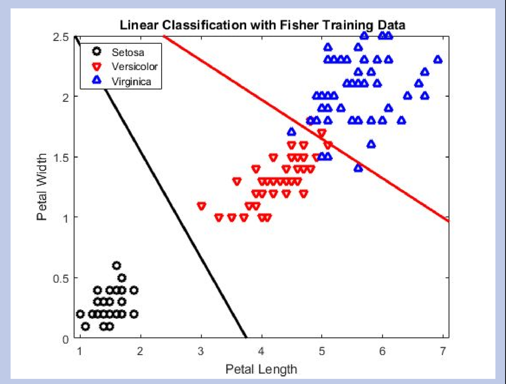
$$(x_k > 0 \ and\ x_{k+1} < 0)\ or\ (x_k < 0\ and\ x_{k+1} > 0), and\ |x_k - x_{k-1}| \geq threshold$$

Zero Crossing (ZERO)

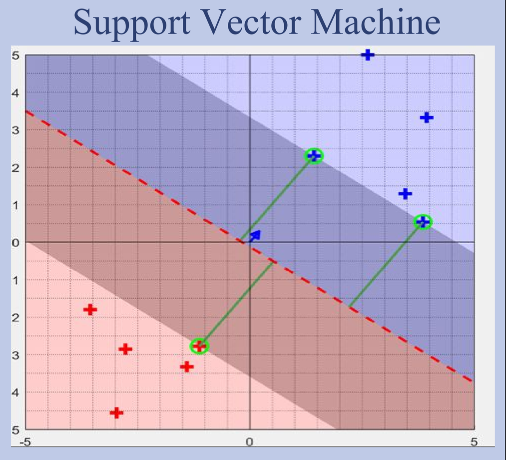
$$(x_k > x_{k-1}\ and\ x_k > x_{k+1})\ or\ (x_k < x_{k-1}\ and\ x_k < x_{k+1}), and$$
$$|x_k - x_{k-1}| > threshold\ or\ |x_k - x_{k+1}| \geq threshold$$

Classifiers

Linear Discriminant Analysis



Support Vector Machine



CONTRIBUTIONS

- Receives IMU data input
- Picture output
- Auto-train feature
- "Feature Selection" grid
- Rudimentary dynamic gesture implementation
- CrossAccuracy function
- Existing pipeline modification to work with the VR game

VIRTUAL REALITY APPLICATION

- Play the VR game to test the usability of using the Myo Armband as a gesture control device
- Player looking into an Oculus Rift VR headset can control the character in the game using trained gestures and arm swings

RESULTS

- Significant improvements to prior version of HMI
  - Usability, functionality
  - Can recognize more gestures
- Groundwork for further development
- Interaction with client application

Control Method	Mouse	Gesture
Score	199.09	104.46
Final health	46.818	7.27
Shooting Accuracy	65.56	59.95

CONCLUSIONS

- The HMI is a viable low-cost gesture recognition platform that can output gesture decisions to a wide range of external clients
- The additions made during this study can be further expanded upon to further improve the interface

FUTURE WORK

- Implement Hidden Markov Models for dynamic gesture recognition
- Customizeable pipeline for client applications

ACKNOWLEDGEMENTS

This work was supported through the ASPIRES (Accelerated STEM Pathways through Internship, Research, Engagement, and Support) program. A collaboration between Cañada College's Engineering Department, San Francisco State University School of Engineering, and the University of California, Merced. The project was funded by a grant from the U.S. Department of Education through the Minority Science and Engineering Improvement Program (MSEIP), Grant No. P120A150014. Special acknowledgements to Christopher Thomas of Cañada College.

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